Robotic Fresh Food Kitchen & Pantry Module Attachment for the International Space Station

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NASA EXPLORATION SCIENCE FORUM

BACKGROUND

- The Artemis mission has motivated further advancements and developments in the Space arena.
- NASA (National Aeronautics and Space Administration) launched the Deep Space Food Challenge, calling all food innovators around the world to take on the challenge of developing novel food production technologies that can support long-duration mission. The challenge is slated to complete by 2024, which is the same timeline as Artemis's plan of returning astronauts to the Moon.
- Historically, space food is limited to pre-packaged meals that are prepared to either be rehydratable, thermostabilized, irradiated, or introduce intermediate moisture.
- Cooking methods in ISS are also limited to using microwave oven, convection oven, or hot water to heat or cook the food.
- Astronauts are provided a set menu for their journey. There are still concerns about the palatability of the food, which affects food intake and leads to under consumption of food by astronauts.
- NASA has announced its plan to commercialize the International Space Station (ISS).

OBJECTIVE

- As NASA plans to convert the ISS into a hotel that accommodates space tourists, the goal of this project is to serve gourmet food that provides space travelers an exceptional dining experience.
- To address the challenges of creating a more palatable meal, providing nutritious and tasty food, and catering to individual's caloric needs.
- To promote commercial human spaceflight expeditions (CHASE) through amazing food experience.
- "*Because food is an important part of life, it is imperative that the space food system is the best it can be…The supply of food must be nourishing and tasty so astronauts maintain their health during their important stays in space.*"

EXISTING RESEARCH AND TECHNOLOGY

- Additive Manufacturing There are products already in the market that 3-D prints food.
- Robot Chef: Able to cook over 5,000 recipes and even clean up after itself when it's done
- 2019: Astrobees are bots that help the astronauts with mundane tasks
- Telerobot: World's first haptic telerobotic system that transmits realistic touch feedback to an operator

Integration of multiple technologies make an automated space kitchen possible

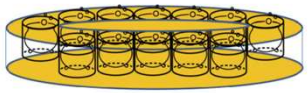
PRESSURE COOKER CONCEPT

- Quickly cooks the food, providing variety and redundancy on pressure cookers

Fill the pot with food to be cooked and seasonings

Any steam is released out through the piston

The Revolving Cylinder: houses all the pressure cooker and it rotates as commanded



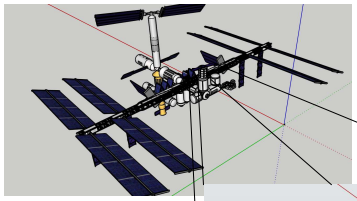
Concept Rationale:

Variety - allowing multiple dishes to be cooked at the same time or different times depending on demand

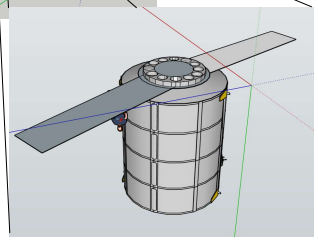
Modularity - each of the pot is independently connected to the power source, and each component can easily be replaced or fixed

Redundancy – has a multiple cooking container concept

CONCEPT ARCHITECTURE

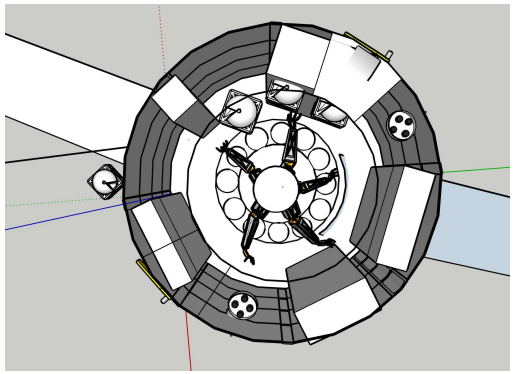


A model of the International Space Station with the kitchen module on the zenith side

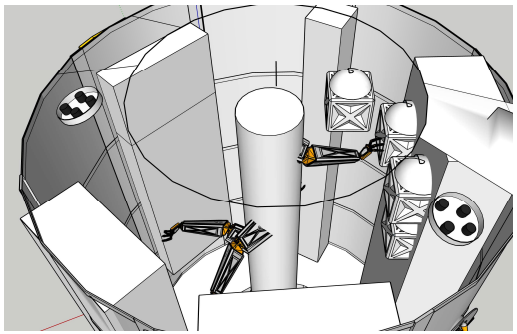


The Kitchen module

INSIDE VIEW



SIDE VIEW

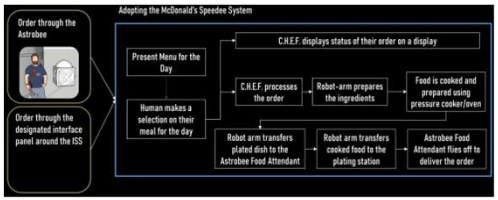


Food is placed in the Astrobees and once filled, Astrobees are launched to serve the food.

KITCHEN MODULES

- *Astrobee Station:* this is where the AstrobeeFood Attendants charge itself and where the robot arms load the plated food to be delivered
- *Environmental Control Module:* controls the temperature, humidity, and pressure in the kitchen module
- *Command & Control Module:* the brain of the kitchen module that orchestrates the dish preparation process
- *Food Storage Module:* stores the fresh food, preserved food, frozen food, sauces, and spices
- Revolving Pressure Cooker Module: houses the 12 pressure cookers and rotates as ingredients are put in for cooking and cooked food is taken out
- *Heating and Food Prep Station:* houses the gadgets to process fresh ingredients, such as slice, grate, cut, peel, juice, etc., and use the convection oven, microwave oven, or hot water as another means to cook food
- *Dish Clean and Prep Station:* transfers food from pressure cookers into a dish, provides a place for serving dishes, holds prepared dishes, and warms the food as it waits for it to be transferred to an available Astrobee

END-TO-END GOURMET FOOD EXPERIENCE



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